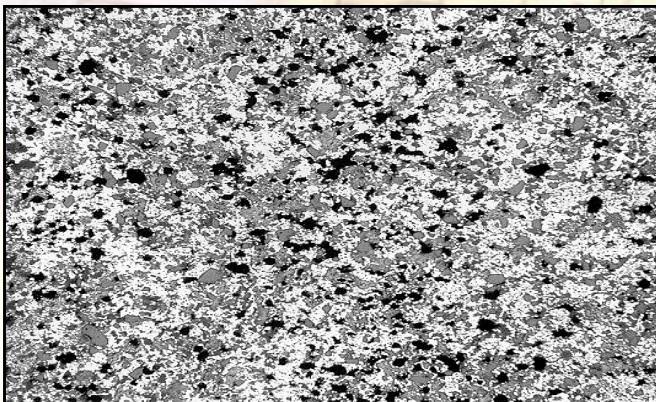


CERMET FILTERS FOR UNDERGROUND MINING DIESEL ENGINE EMISSION CONTROL

Diesel engines contribute considerable pollution to our nation's continuing air quality problems. Even with more stringent heavy-duty engine standards set to take effect in 2004, these engines will continue to emit large amounts of nitrogen oxides and particulate matter, both of which contribute to serious public health problems in the United States. It is expected that the U.S. Environmental Protection Agency (EPA) will begin tightening the regulatory requirements to control soot and NO_x emissions from diesel powered vehicles. As a result, diesel vehicles would achieve gasoline-like exhaust emission levels, in addition to their inherent advantages over gasoline vehicles with respect to fuel economy, lower greenhouse gas emissions, and lower evaporative hydrocarbon

Microstructure of the Cermet Filter



emissions. The Idaho National Engineering and Environmental Laboratory (INEEL) has invented a self-cleaning, high temperature cermet filter technology that controls the heavy-duty diesel engine emissions.

A single-step combustion synthesis process forms INEEL's cermet filter. Metal and ceramic powders are well mixed with sacrificial filler materials to form a near net shape compact. The compact is fired at high temperatures to initiate the self-propagating combustion synthesis process. The synthesis is complete when all the metal components are reacted forming a net shape structure.

The cermet filter can be brazed to existing structures and is self-cleaning. Other properties include: high melting temperatures, thermal shock resistance, can be made catalytic to oxidize CO, H₂, hydrocarbons, and for NO_x reduction, controlled porosity for high removal efficiency for carbon particulate, inexpensive starting materials, and net shape bulk forming by a single-step combustion synthesis process. It has high heat capacity, and is lightweight and mechanically strong. It is thermal expansion coefficient

controllable, and has high particulate filtration efficiency.

Advantages/Benefits

The main advantage of INEEL's cermet filter, compared to current technology, is its capability to reduce carbon particles and NO_x in the diesel engine exhaust. Under high engine exhaust temperatures, the cermet filter would clean-up carbon particles and NO_x simultaneously in the exhaust gas. As a result, this technology is expected to improve and maintain our nation's environmental quality by meeting the need for heavy-duty diesel engine emissions control.

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Some performance tests of

(over)

the cermet filter are listed in the following tables.

Table 1. Cermet Filter Reduction of NO under Reducing Conditions.

	% NO conversion to N ₂ under reducing atmosphere		
Temperature, °C	Cermet 1	Cermet 2	Intermetallics
300	0	0	0
400	0	2.5	0
475	0	2.6	2
550	0	4.7	2
623	3.8	13.3	2
696	11.3	43.1	3
797	38.7	98.3	7
904		100	

Table 2. Cermet Destruction of Hydrocarbon and CO.

°C	C ₃ H ₆	CH ₄	CO
25	0	0	0
101	0	0	0
203	2.1	0	5.3
302	1.4	0	6.1
403	0	0	8.9
478	11.3	15.9	24
553	47.8	23.3	81.2
627	93.8	25.2	97.0
702	100	36.0	100
797	100	52	100

Table 3. Fine Particle Particulate Filtration Tests.

Initial wt of cermet filter = 3.3073g	Wt of carbon before filtering = 1.3846g
Final wt of cermet filter = 3.3070g	Wt of carbon after filtering = 1.3826g
No clogging of the filter observed	Carbon filtration efficiency = 99.86%
Effective cermet filter area = 0.78 in ²	Filter porosity = 30%

Carbon particles generated by thermal plasma decomposition of methane. The average particle size of carbon is 0.5 micron.

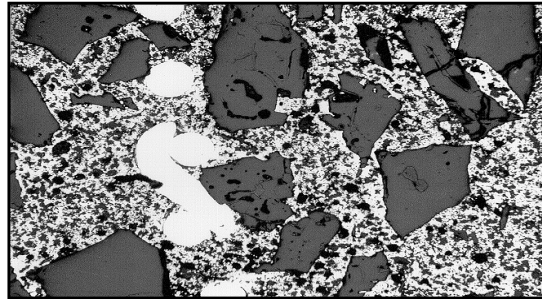
Cermet Filters For Underground Mining Diesel Engine Emission Control

Diesel engines contribute considerable pollution to our nation's continuing air quality problems. These engines emit large amounts of nitrogen oxides, hydrocarbon, sulfur oxides and particulate matter, all of which contribute to serious public health problems in the United States. Under ground mining operations employ large numbers of heavy-duty diesel trucks for ore transportation. The confine condition in an under ground mine amplifies the harmful effects of the diesel engine emissions to the well being of mine workers. The Idaho National Engineering and Environmental Laboratory is developing a cermet filter technology that will help solve these problems in underground mining operations.

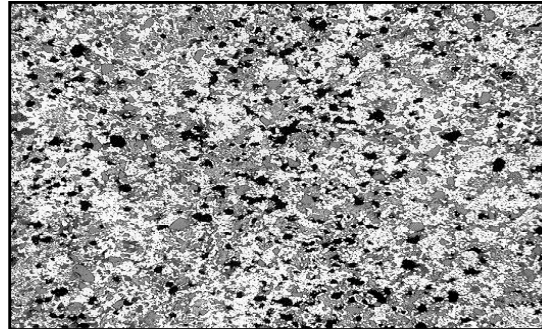
Properties of Cermet Filter

- Inexpensive starting materials
- High melting temperature
- High heat capacity
- Thermal shock resistant
- Thermal expansion coefficient controllable
- Light weight and mechanically strong
- Tailored material compositions
- Net shape bulk forming by combustion synthesis
- Controlled porosity
- Self-heating capability
- Oxidation of hydrocarbon to CO_2 & H_2
- NO_x reduction under reducing condition
- Could be made for SO_x removal
- High particulate filtration efficiency

Cross Section of Cermet Filters



Cermet filter with coarse ceramic phase



Cermet filter with fine ceramic phase

